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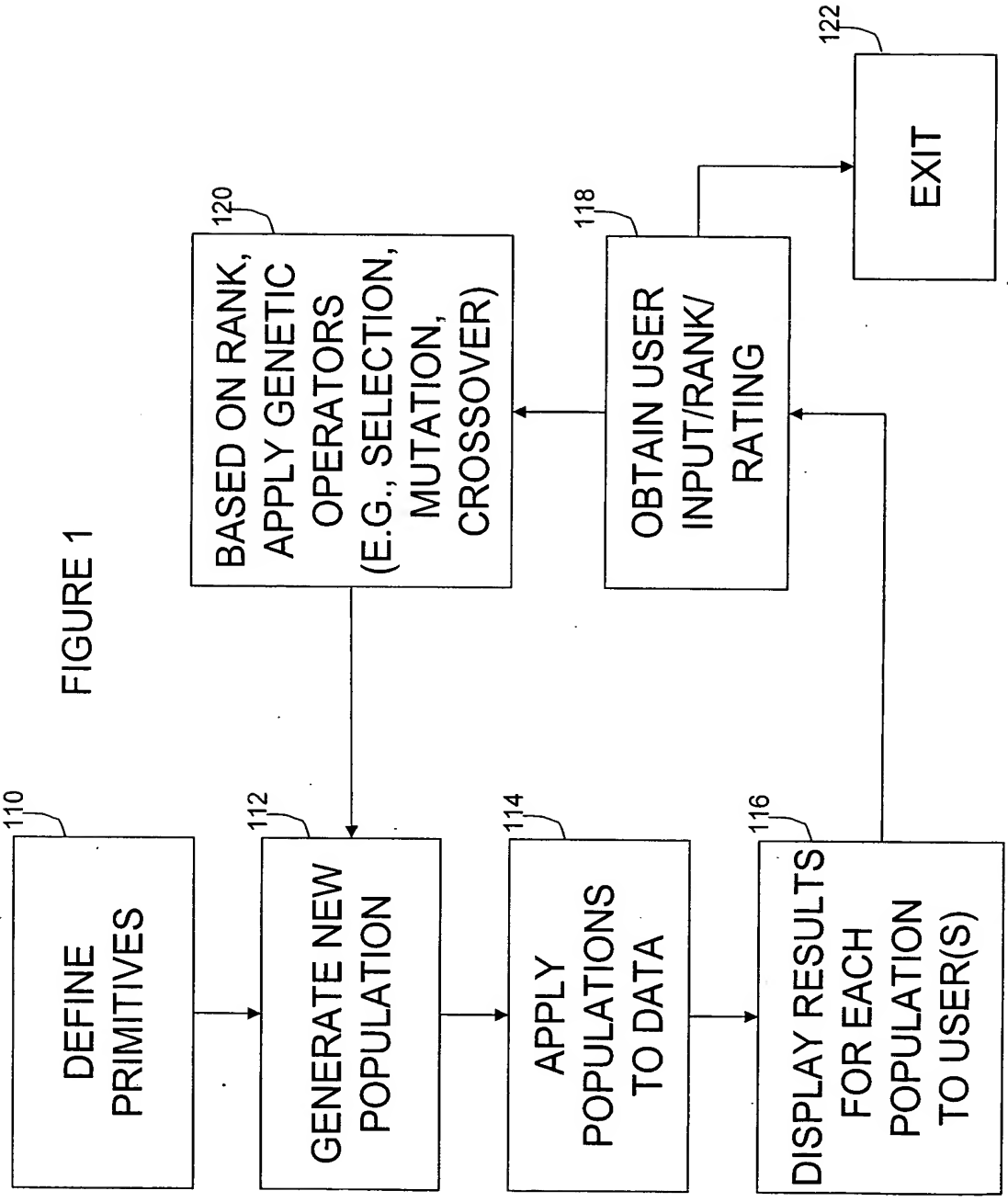
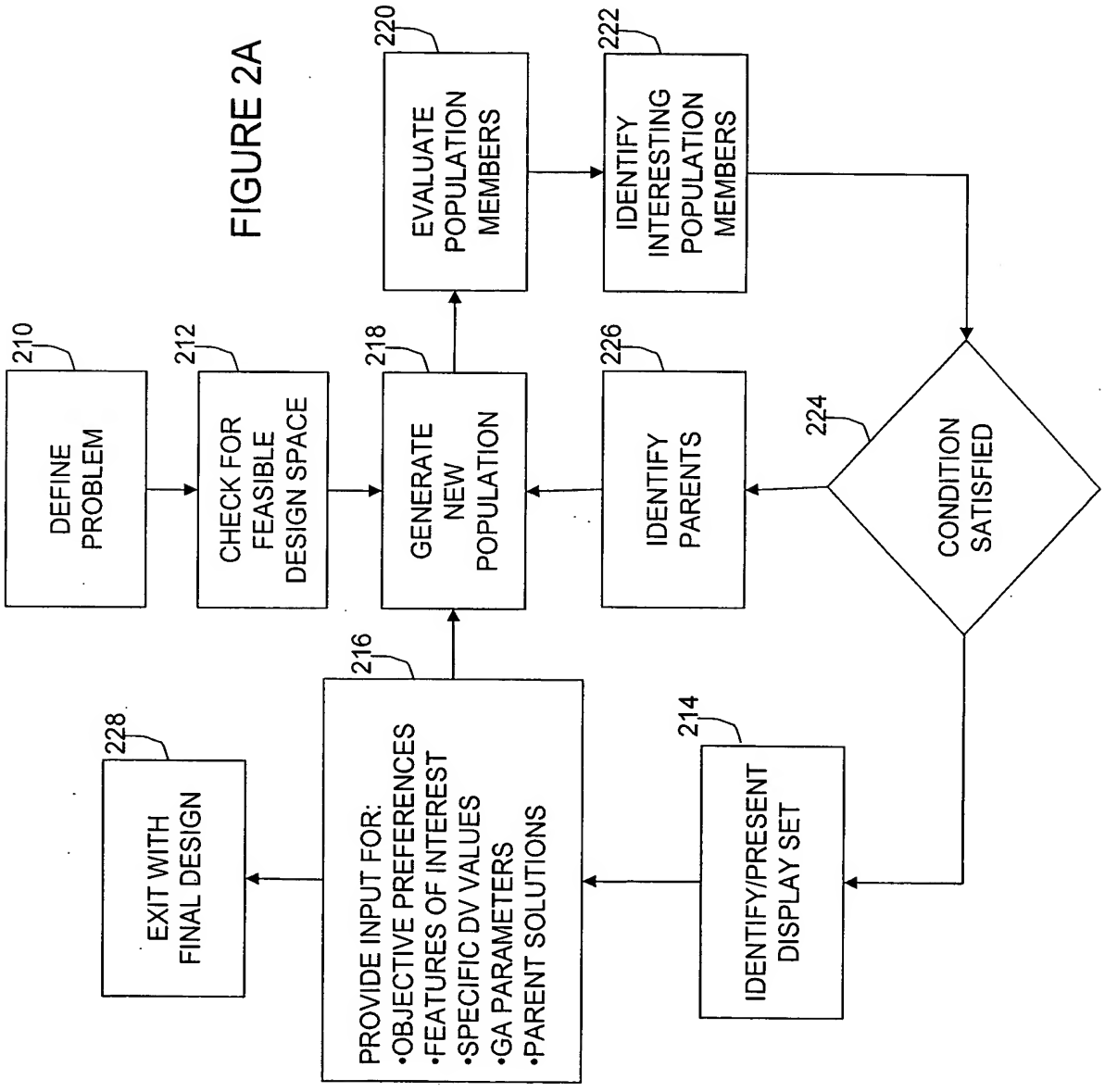

110
DEFINE PRIMITIVES
112
GENERATE NEW POPULATION
114
APPLY POPULATIONS TO DATA
116
DISPLAY RESULTS FOR EACH POPULATION TO USER(S)
118
OBTAIN USER INPUT/RANK/ RATING
120
BASED ON RANK, APPLY GENETIC OPERATORS (E.G., SELECTION, MUTATION, CROSSOVER)
122
EXIT

FIGURE 1

FIGURE 2A


210
DEFINE PROBLEM
212
CHECK FOR FEASIBLE DESIGN SPACE
218
GENERATE NEW POPULATION
220
EVALUATE POPULATION MEMBERS
222
IDENTIFY INTERESTING POPULATION MEMBERS
224
CONDITION SATISFIED
226
IDENTIFY PARENTS
228
EXIT WITH FINAL DESIGN
216
PROVIDE INPUT FOR:
•OBJECTIVE PREFERENCES
•FEATURES OF INTEREST
•SPECIFIC DV VALUES
•GA PARAMETERS
•PARENT SOLUTIONS
214
IDENTIFY/PRESENT DISPLAY SET

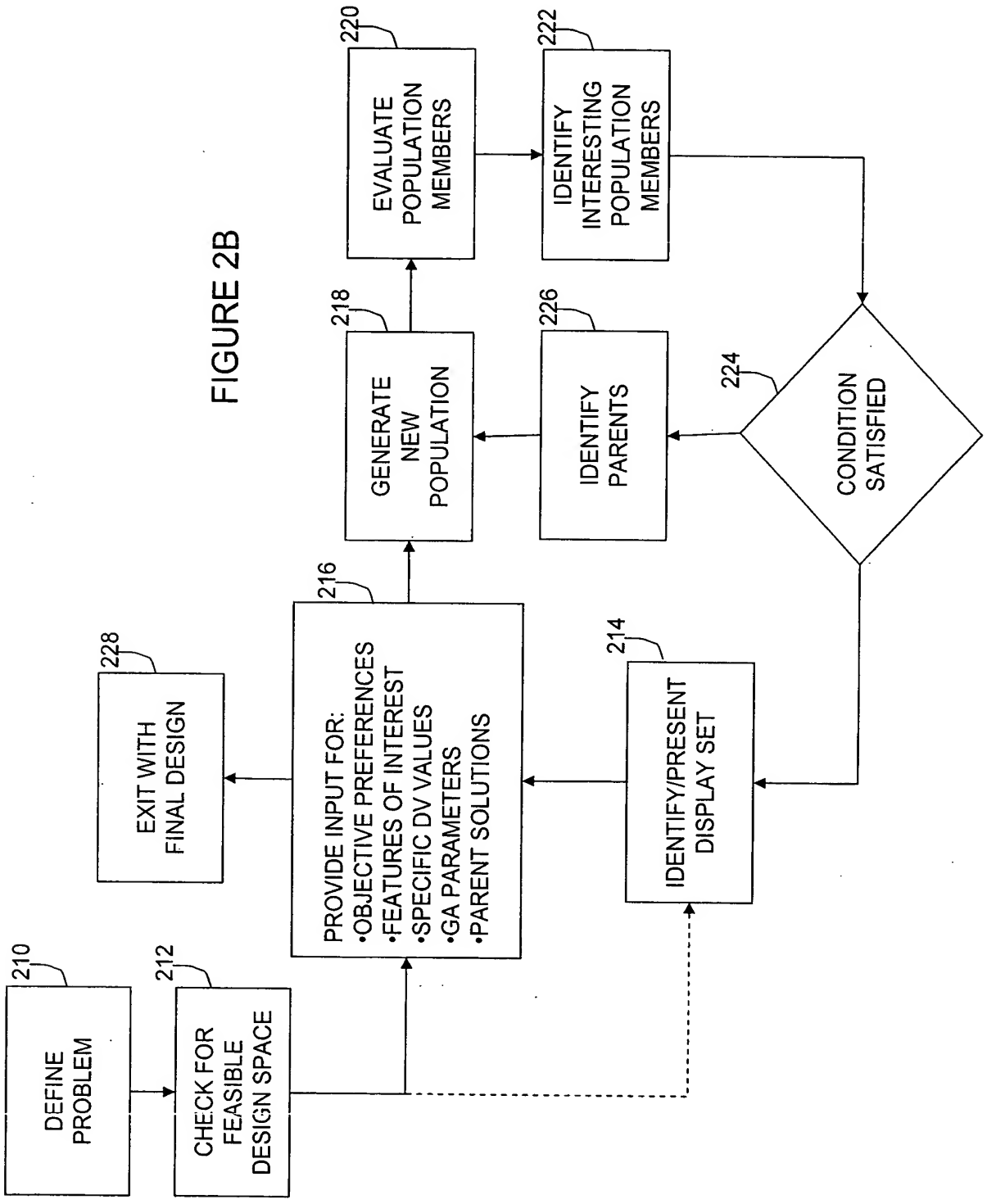

210
DEFINE PROBLEM
212
CHECK FOR FEASIBLE DESIGN SPACE
216
PROVIDE INPUT FOR:
•OBJECTIVE PREFERENCES
•FEATURES OF INTEREST
•SPECIFIC DV VALUES
•GA PARAMETERS
•PARENT SOLUTIONS
228
EXIT WITH FINAL DESIGN
214
IDENTIFY/PRESENT DISPLAY SET
218
GENERATE NEW POPULATION
226
IDENTIFY PARENTS
224
CONDITION SATISFIED
220
EVALUATE POPULATION MEMBERS
222
IDENTIFY INTERESTING POPULATION MEMBERS

FIGURE 2B

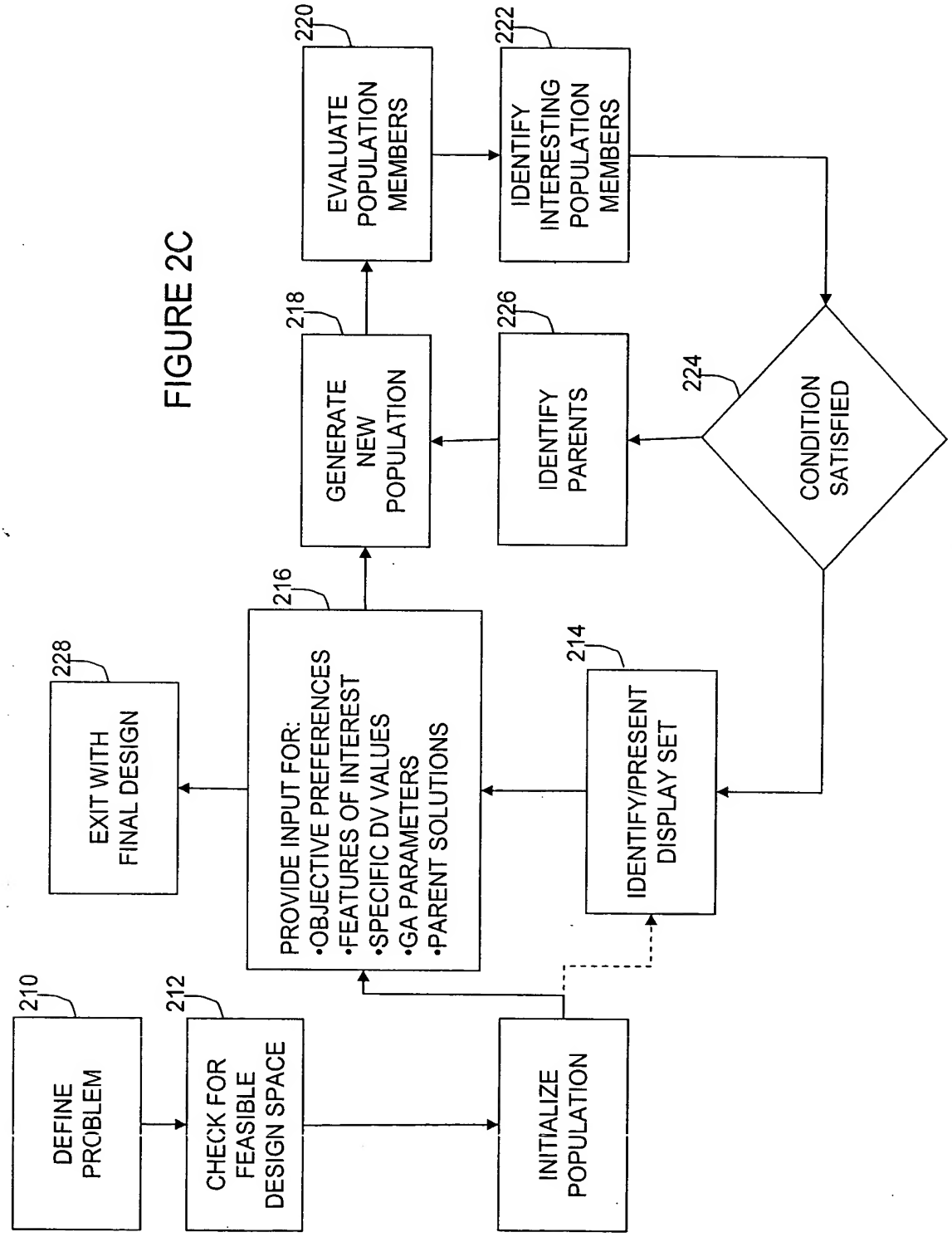
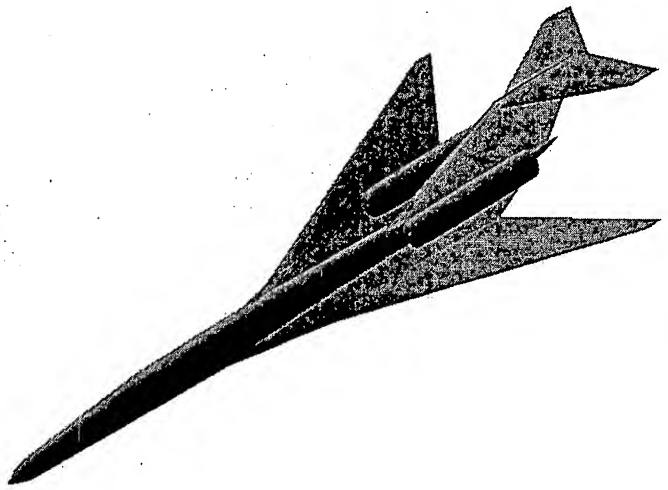

DEFINE PROBLEM
210
CHECK FOR FEASIBLE DESIGN SPACE
212
INITIALIZE POPULATION
PROVIDE INPUT FOR:
•OBJECTIVE PREFERENCES
•FEATURES OF INTEREST
•SPECIFIC DV VALUES
•GA PARAMETERS
•PARENT SOLUTIONS
216
EXIT WITH FINAL DESIGN
228
IDENTIFY/PRESENT DISPLAY SET
214
GENERATE NEW POPULATION
218
IDENTIFY PARENTS
226
CONDITION SATISFIED
224
EVALUATE POPULATION MEMBERS
220
IDENTIFY INTERESTING POPULATION MEMBERS
222

FIGURE 2C

Iteration: Set-Up	Project: Supersonic Business Jet



Objectives

Name	Preference	Norm Factor
Acquisition Cost (Mill 2002 $)	0.2	90
Direct Operating Cost ($/SM)	0.1	1.5
Take-Off Gross Weight (lbs)	0.1	200000
Specific Fuel Consumption ($lb_f/lb_m/hr$)	0.1	1.2
Boom Loudness (dB)	0.2	88
Sideline Noise (dB)	0.1	95
Flyover Noise (dB)	0.1	88
Approach Speed (kts)	0.1	150

Constraints

Name	Constraint
Sideline Noise (dB)	< 95
Flyover Noise (dB)	< 88
Approach Speed (kts)	< 150
Landing Field Length (ft)	< 9000
Take-Off Field Length (ft)	< 9000
Max Overpressure (lbs/ft^2)	< 0.95
Fuel Available (lbs)	> 1000

General

Name	Min	Max
# of PAX	8	12
Manuf. ROI	6	12
# of Vehicles	200	500
Design Range (nm)	3500	4200
Mach	1.6	1.8
TO Thr Der.	0.8	1

Wing

Name	Min	Max
Location (ft)	45	57
AR	2	2.5
TR	0.05	0.3
Area (ft^2)	2300	3100
Sweep (deg)	67	74
F Str-Bod Int.	0.4	0.8
F Str-Wng Int.	0.2	0.4
A Str-Bod Int.	0.4	0.6
A Str-Wng Int.	0.2	0.5
TCR - root	0.025	0.045
TCR - tip	0.025	0.045
Twist – root	-2	2
Twist - tip	0	5

Fuselage

Name	Min	Max
Length (ft)	135	160
Cabin Loc. (ft)	36	41
Cabin Length (ft)	39	50
Diameter 1 (ft)	2.2	3
Diameter 2 (ft)	7.2	7.6
Diameter 3 (ft)	7.2	8
Diameter 4 (ft)	7.2	7.6
Diameter 5 (ft)	4.5	6.5
Diameter 6 (ft)	2.3	3.1

Empennage

Name	Min	Max
Location (ft)	87	97

Engine

Name	Min	Max
Location (ft)	100	110
OPR	22	29
TIT (degR)	3300	3400
FPR	2.6	3.2
Throttle Ratio	1.2	1.23
T/W Ratio	0.41	0.45

Figure 3

Figure 4

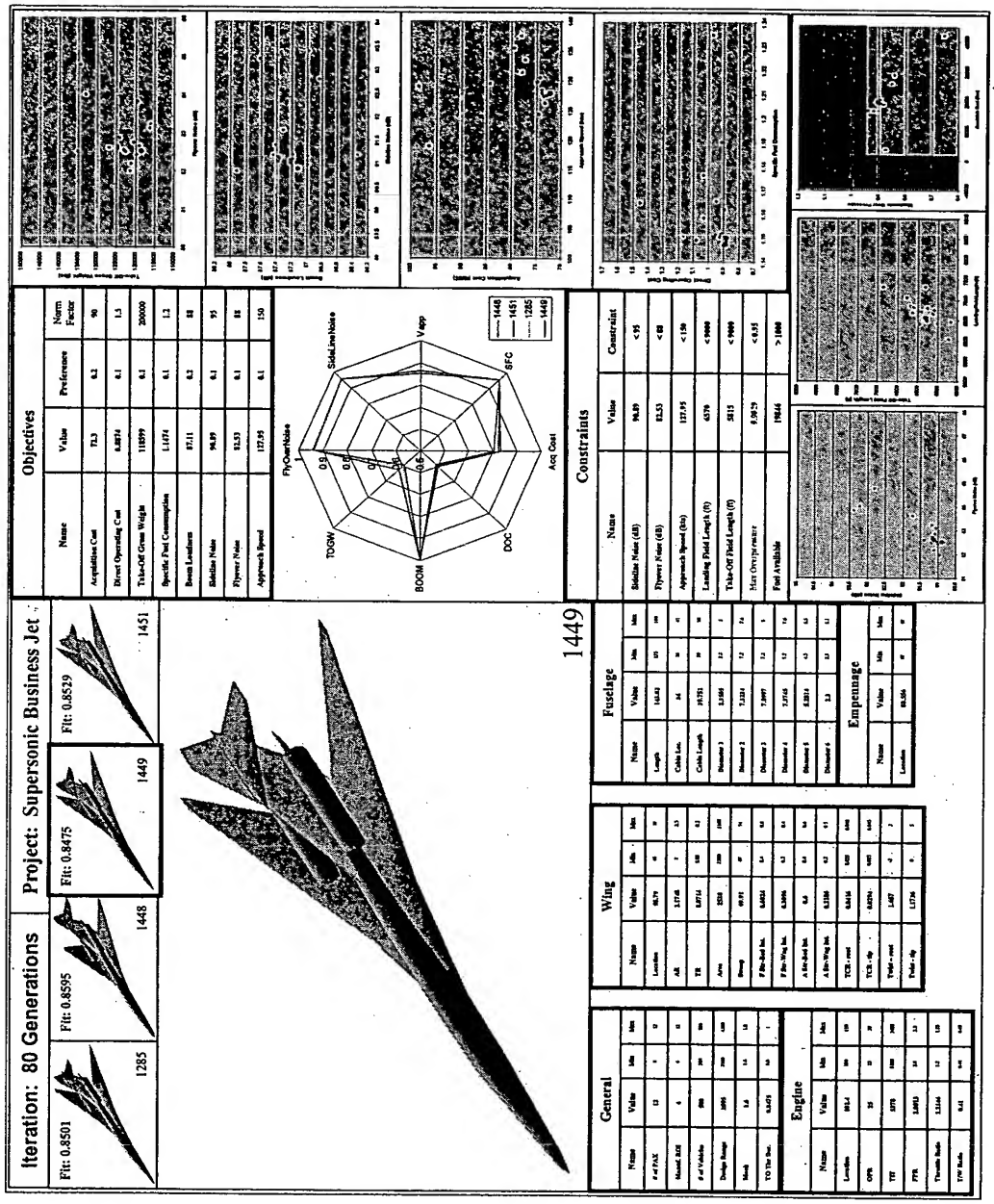
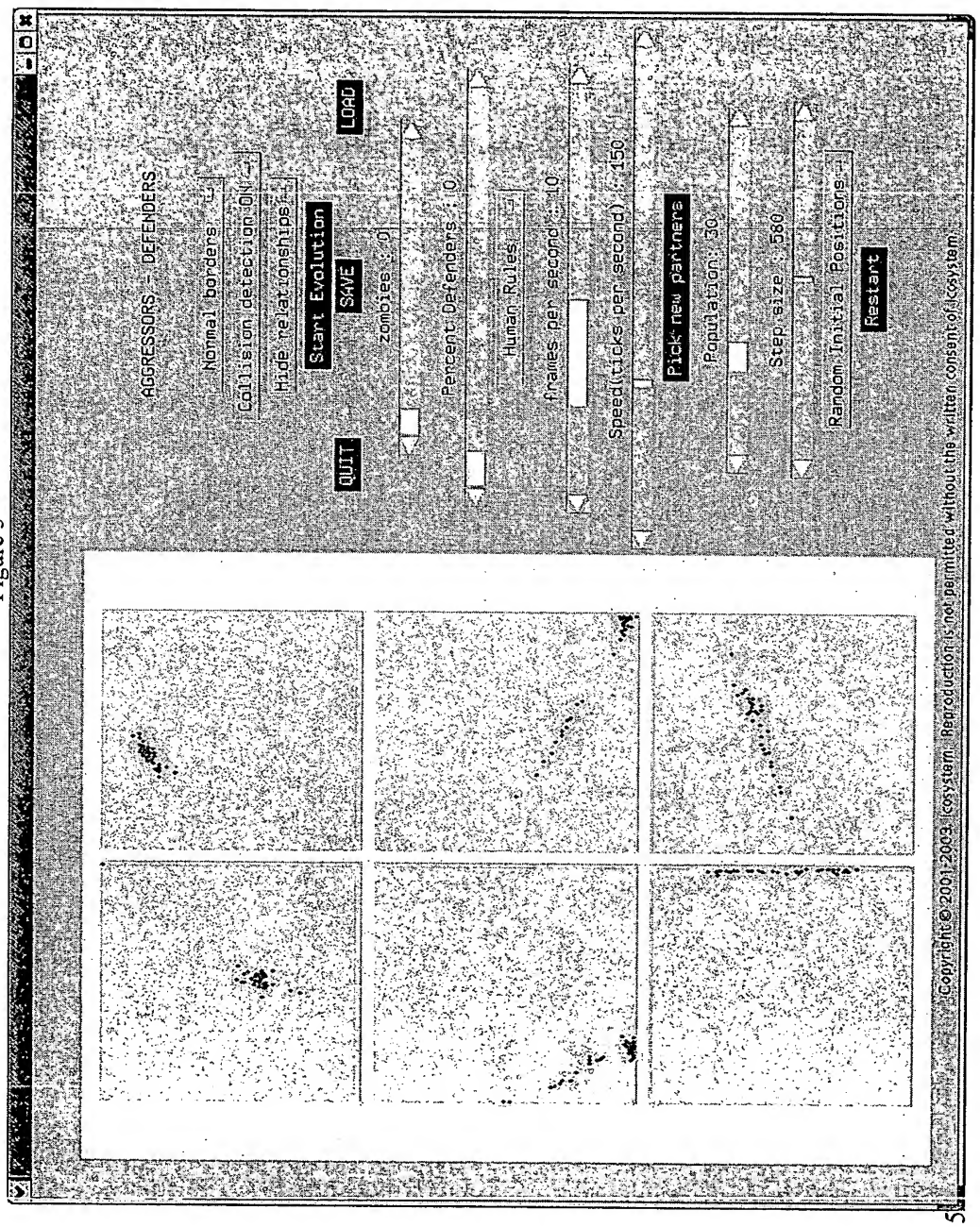

Iteration: 80 Generations
Project: Supersonic Business Jet
Fit: 0.8501
Fit: 0.8595
Fit: 0.8475
Fit: 0.8529
1285
1448
1449
1451
1449
Objectives
Name
Value
Preference
Norm Factor
Acquisition Cost
Direct Operating Cost
Take-Off Gross Weight
Specific Fuel Consumption
Sideline Noise
Flyover Noise
Approach Speed
Constraints
Name
Value
Constraint
Sideline Noise (dB)
Flyover Noise (dB)
Approach Speed (kts)
Landing Field Length (ft)
Take-Off Field Length (ft)
Mid-Cruise Mach
Fuel Available
General
Wing
Fuselage
Empennage
Engine
SideLineNoise
Vapp
SFC
Acq Cost
DOC
BOOM
TOGW
FlyOverNoise
1448
1451
1285
1449

Figure 5


AGGRESSORS - DEFENDERS
Normal borders
Collision detection:ON
Hide relationships
Start Evolution
SAVE
LOAD
QUIT
zombies : 0
Percent Defenders : 10
Human Rules
frames per second : 10
Speed(ticks per second) : 150
Pick new partners
Population: 30
Step size : 580
Random Initial Positions
Restart
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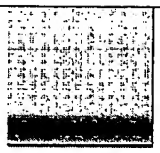


Figure 6A: Pure Sine Wave Spectrogram

Figure 6B: Spectrogram of a Combination of Sine Waves

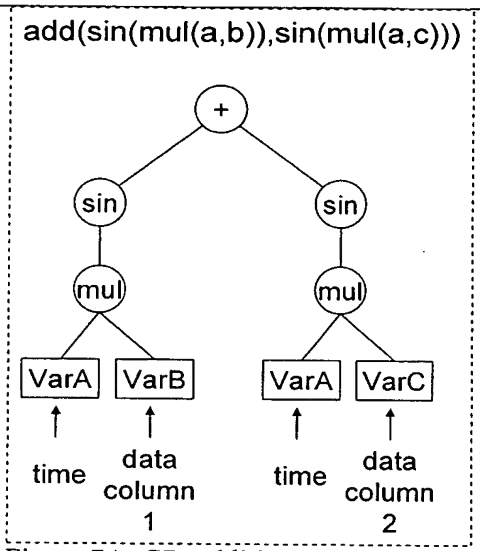


Figure 7A: GP Additive Synthesis with Data Mapped to Terminals

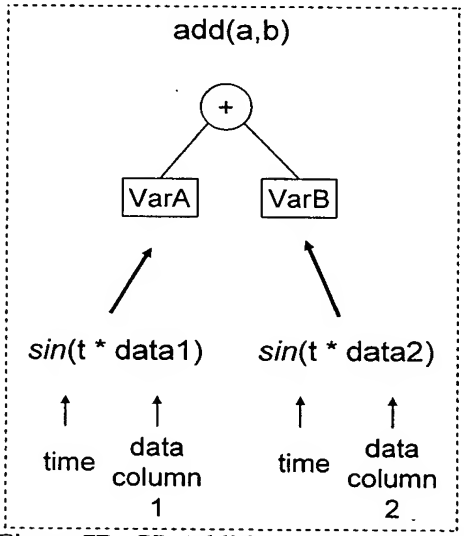
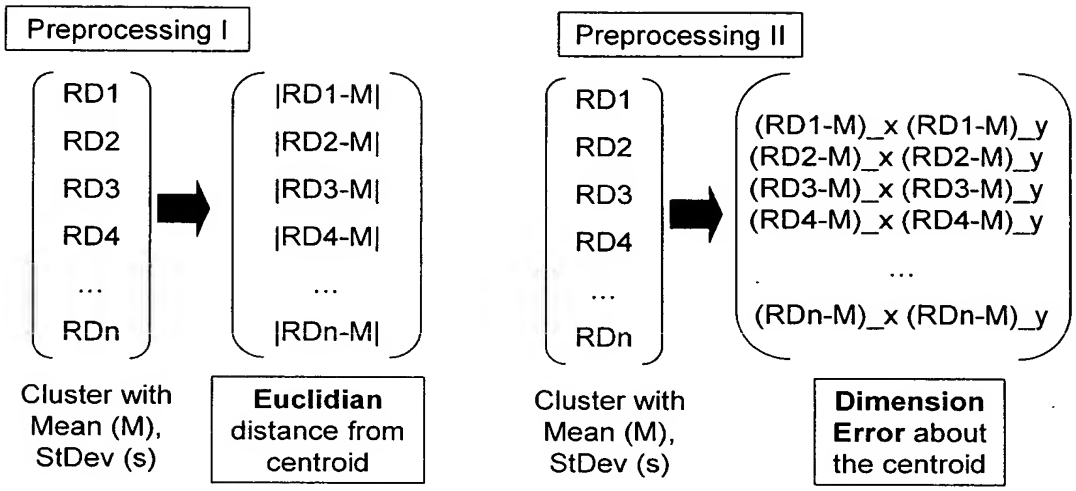


Figure 7B: GP Additive Synthesis with Preprocessed Wave Input



Figures 8A and 8B: Preprocessing for Clusters

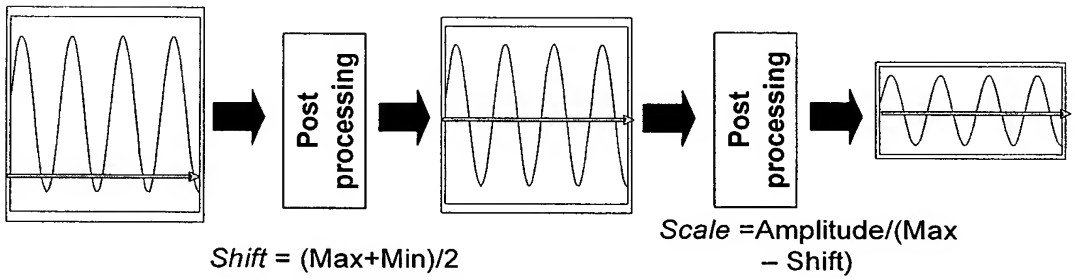


Figure 9: Post Processing of Sound Data

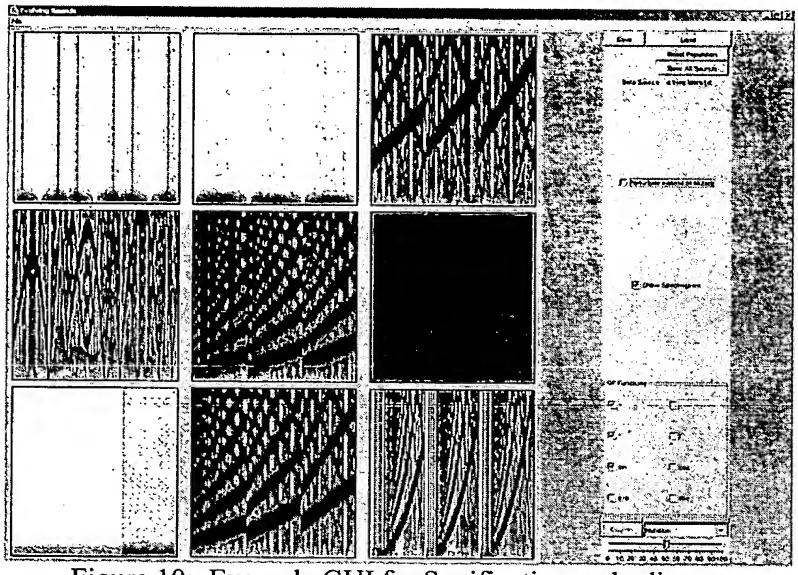


Figure 10: Example GUI for Sonification embodiment

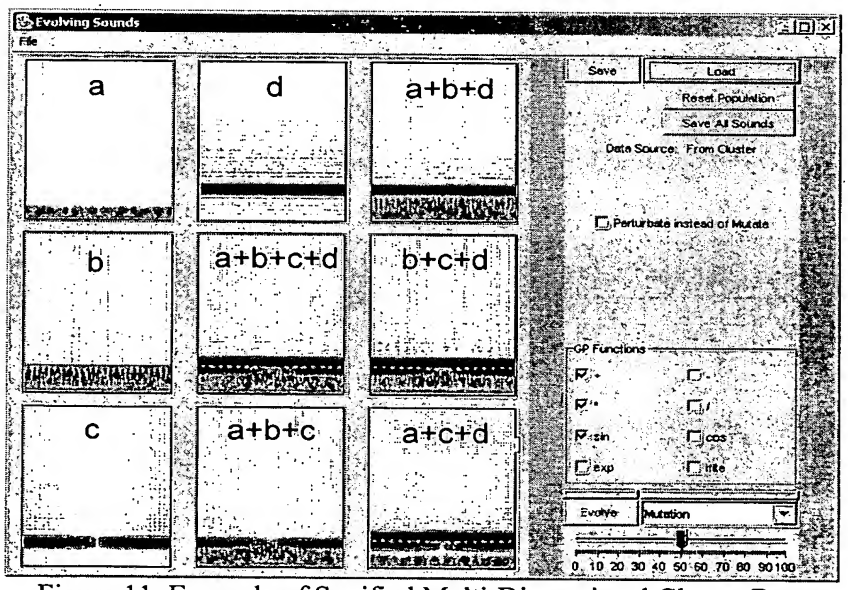


Figure 11: Example of Sonified Multi-Dimensional Cluster Data

$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$	$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{bmatrix}$	$\begin{bmatrix} -2 & -1 & 0 \\ -1 & 1 & 1 \\ 0 & 1 & 2 \end{bmatrix}$	$\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}$
Blur	Sharpen	Emboss	Edge Detection

Figure 12: Sample Convolution Kernels

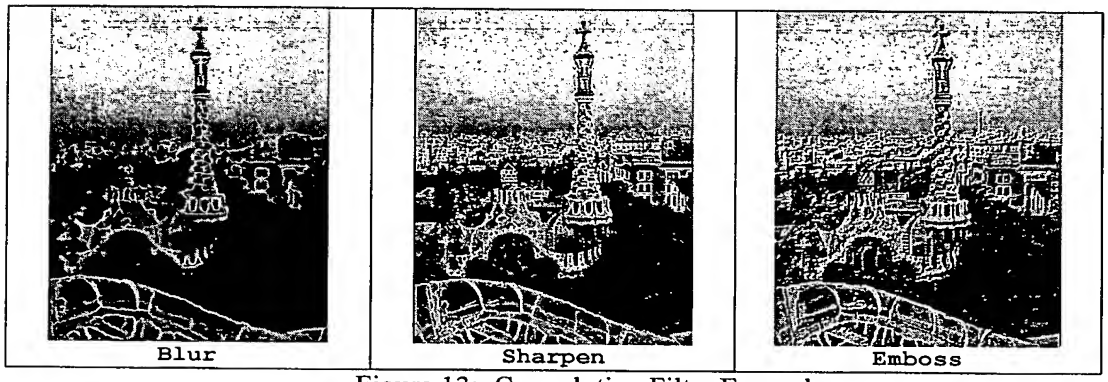


Figure 13: Convolution Filter Examples

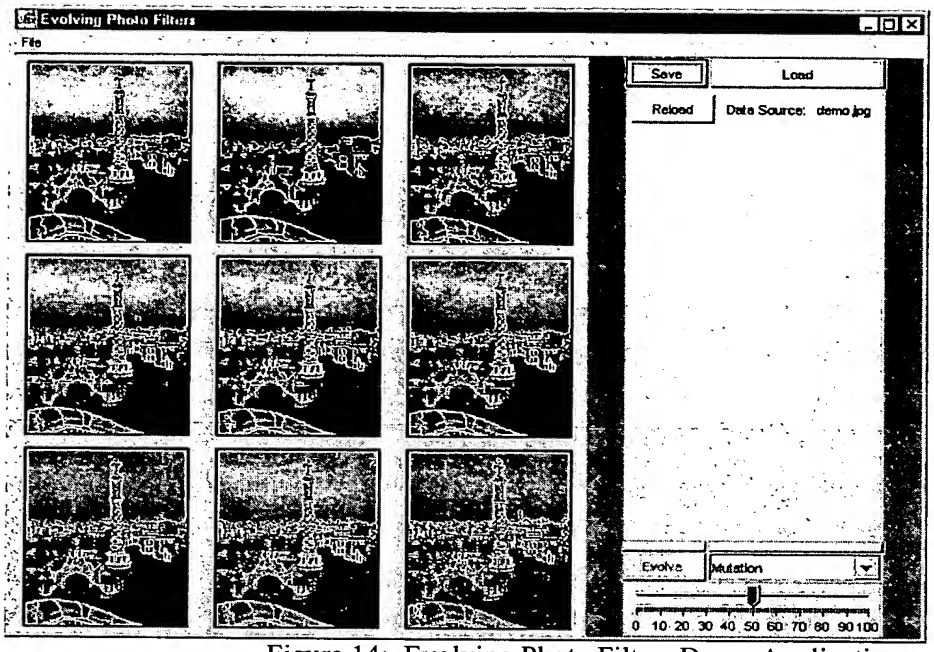


Figure 14: Evolving Photo Filters Demo Application